ACCESSION #: 9606200154

LICENSEE EVENT REPORT (LER)

FACILITY NAME: Brunswick Steam Electric Plant, Unit 1 PAGE: 1 OF 5

DOCKET NUMBER: 05000325

TITLE: Unit 1 Manual Reactor Scram Due to Main Turbine Vibration

EVENT DATE: 01/23/96 LER #: 96-02-01 REPORT DATE: 05/ /96

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 01 POWER LEVEL: 28

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:

50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:

NAME: Steve Tabor, Senior Analyst,

Regulatory Affairs TELEPHONE: (910) 457-2178

COMPONENT FAILURE DESCRIPTION:

CAUSE: B SYSTEM: AA COMPONENT: V MANUFACTURER: G080

REPORTABLE NPRDS: Y

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On January 23, 1996, with the Unit 1 reactor operating at 28% power and undergoing a planned reactor shutdown to correct previously identified control rod slow scram insertion times, main turbine bearings experienced increasing vibration. When vibration levels approached the procedural limits, a manual reactor scram was initiated at approximately 0657 hours. Reactor water level momentarily decreased below the low level 1 setpoint (162.5"), resulting in Primary Containment Isolation System (PCIS) Group 2 (Drywell Floor and Equipment Drains) and Group 6 (Containment Atmospheric Control) valve isolations. In addition, a Group 8 (Shutdown Cooling) isolation signal occurred; however, the Group 8 valves were already closed at the time of the shutdown.

The plant responded as expected. Following completion of repairs to the Unit 1 hydraulic control units and Plant Nuclear Safety Committee review of the event recovery effort, Unit 1 reactor power ascension commenced. On January 25, 1996, at 0435 hours, the Unit 1 main generator was synchronized to the electrical grid system.

Investigation into the cause of the increased turbine vibration determined that diaphragm packing rubs on the recently installed monoblock low pressure turbine rotors caused hot spots on the rotor shaft which created bowing of the rotor shaft and subsequently resulted in increased turbine bearing vibration levels. The primary cause of the slow control rod scram insertion times has been isolated by diagnostic and laboratory testing to be adherence of the SSPV's exhaust diaphragm to the valve seat. Additional procedural guidance for coping with increased main turbine vibration will be incorporated into the plant shutdown procedure. Corrective actions related to the control rod slow scram insertion times include replacement of the Scram Solenoid Pilot Valve (SSPV) exhaust diaphragms with Buna-N diaphragm material and implementation of an accelerated SSPV monitoring program.

The safety significance of the scram event is minimal in that the plant responded as designed and the Emergency Core Cooling Systems were operable at the time of the event.

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TITLE

Unit 1 Manual Reactor Scram Due to Main Turbine Vibration

INITIAL CONDITIONS

Unit 1 was operating at 28% reactor power and undergoing a planned

reactor shutdown. The shutdown was initiated on January 23, 1996, to

allow repairs of the Control Rod Drive (CRD) system hydraulic control

units. The Unit 1 Residual Heat Removal, High Pressure Coolant

Injection, Core Spray, and Reactor Core Isolation Cooling systems were

operable.

EVENT NARRATIVE

On January 20, 1996, Technical Specification required control rod scram

time testing on ten percent of the Unit 1 control rods was performed. Twelve of the fourteen controls rods in the sample exceeded the Technical Specification core-wide average limit (0.358 seconds) for insertion to notch 46 by approximately 0.043 seconds; however, the core average Technical Specification limit was not exceeded. To determine whether a generic problem existed with control rod scram times, an engineering investigation team was assembled on January 21, 1996. Utilizing fault tree analysis techniques, the investigation team developed a diagnostic plan to determine the cause of the timing indications. On January 21 and 22, 1996, a series of tests were performed on additional selected control rods. These tests validated that the delay in scram times was a generic problem and attributable to the Scram Pilot Solenoid Valve (SSPV) assemblies. Details of the testing performed on January 21 and 22, 1996, are provided in NRC Information Notice 96-07 and INPO Operational Experience Report 7652 dated January 26, 1996.

On January 23, 1996, based on the results of the diagnostic testing, BNP management decided to shutdown the Unit 1 reactor to replace the SSPV exhaust diaphragms and continue diagnostic testing. While reducing reactor power, several of the main turbine bearings experienced increasing vibration. With vibration levels at approximately 11.6 mils on bearing number 5 and approaching the procedural limits, a manual reactor scram as inserted at approximately 0657 hours. Reactor water level momentarily decreased below the low level 1 setpoint (162.5"),

resulting in Primary Containment Isolation System (PCIS) Group 2 (Drywell Floor and Equipment Drains) and Group 6 (Containment Atmospheric Control) valve isolations. In addition, a Group 8 (Shutdown Cooling) isolation signal occurred; however, the Group 8 valves were already closed at the time of the shutdown. Startup level control was placed in service to maintain normal reactor vessel operating level. At approximately 071 0 hours, the PCIS isolations were reset and the affected systems returned to service. The reactor was maintained in the Hot Shutdown mode of operation until repairs to the SSPVs could be completed. A Site Incident Investigation Team (SIIT) was organized to investigate the scram and determine the actions necessary for restart of the Unit 1 reactor.

Following the scram, the five percent insertion time data of 79 control rods were retrieved and applied to the core average. The data indicated that the core-wide average five percent insertion time was approximately 0.380 seconds, which exceeded the Technical Specification 3.1.3.3 limit for insertion to notch 46 (0.358 seconds). Additionally, 25 two-by-two control rod arrays exceeded the Technical Specification 3.1.3.4 limit for average scram insertion time. After replacement of the SSPV exhaust diaphragms the core average measurement following reactor startup was 0.309 seconds.

Following completion of repairs to the Unit 1 SSPVs and Plant Nuclear Safety Committee (PNSC) review of the SIIT report, Unit 1 reactor power ascension commenced. On January 25, 1996, at 0435 hours, the Unit 1 main

generator was synchronized to the electrical grid system.

This event is being reported in accordance with the requirements of 10 CFR 50.73 (a)(2)(iv) in that the increased turbine vibration resulted in the manual actuation of the Reactor Protection System.

CAUSE OF EVENT

An investigation team comprised of CP&L turbine specialists, vendor representatives, and a third party reviewer evaluated the credible failure modes for the turbine vibration problem. The results of this investigation determined that diaphragm packing rubs on the recently installed monoblock low pressure turbine rotors caused localized heating on the rotor shaft. The localized heating created bowing of the rotor shaft and subsequently increased vibrations at the main turbine bearings. Monoblock rotors are more susceptible to vibrations created by diaphragm packing rubs than earlier rotor designs. This inherent susceptibility is mainly due to the location of the diaphragm packing. Monoblock rotor diaphragm packing is located on the rotor shaft at each stage of the rotor. In contrast, the packing on the earlier rotors was located on the rotor shaft only near the center of the rotor (9th stage). Therefore, the monoblock rotors are more susceptible to rubs between the rotor shaft and diaphragm packing when operating conditions change.

Investigation of bearing vibration data after the scram showed some increased vibration at the 55% power plateau on January 22, 1996, after

the initial power reduction. This vibration increased during the next power ramp-down to levels requiring a turbine trip. This was the first operation at these power levels on Unit 1 since installation of the monoblock rotors. The vibrations are believed to have resulted from rubs similar to those experienced during the initial startup of Unit 1 after the B110R1 outage in May 1995. The steam packing in the diaphragms and shaft packing were replaced as part of the rotor replacement during the B110R1 outage. By operating the turbine in a careful manner during startup, the packing was rubbed out providing additional clearance and reducing vibration. The rubs were not seen during the two reactor scrams and subsequent startups that occurred during the summer of 1995. The apparent reason these "rubs" did not appear at that time, is due to the differences in the operating conditions. Seasonal changes in circulating water temperature (winter vs. summer) and low power levels resulted in lower hood temperatures and a different temperature differential across the LP turbines, increasing the conditions that would promote a rub.

The primary cause of the slow control rod scram insertion times has been isolated by diagnostic and laboratory testing to be adherence of the SSPV's exhaust diaphragm to the valve seat. This adherence phenomena has been demonstrated in independent tests at both the Automatic Switch Company (ASCO) and General Electric (GE) and appears to be characteristic of the diaphragm material. The Unit 1 SSPVs are the "dual type" ASCO solenoid valves. The Unit 1 valves were replaced during the 1995 spring

refuel outage with a new design ASCO solenoid valve and had been in-service for approximately 8 months. The newly designed valve uses a Viton diaphragm instead of the original Buna-N diaphragm. The Viton replacement diaphragm is the result of a Boiling Water Reactor Owners Group (BWROG) effort and is recommended by GE SIL 585 and qualified by GE NEDC 32365P.

Two outside laboratories were contracted to perform more extensive chemical analysis on a sample of the SSPV Viton diaphragms in an attempt to further isolate the failure mechanism. These analyses were unable to conclusively determine the specific cause for the Viton adherence phenomenon. Therefore, the exact cause remains indeterminate.

CORRECTIVE ACTIONS

During Unit 1 power ascension following the scram, additional vibration monitoring equipment was installed to monitor the main turbine performance and provide detailed diagnostic vibration information. The turbine vibration data remained acceptable during reactor restart.

Engineering has developed recommendations for coping with increased main turbine vibration and these recommendations will be incorporated into the plant shutdown procedure.

An engineering evaluation was performed to provide an operability assessment of the Unit 1 CRD system with new Viton diaphragms installed. The evaluation provided a basis for the acceptability of replacing the

Unit 1 degraded SSPV diaphragms with new diaphragms. The 137 inboard and outboard SSPV exhaust diaphragms and end caps were replaced prior to startup of Unit 1. Testing of the control rod scram insertion times during reactor startup power ascension demonstrated that the new diaphragms restored the control rod insertion times well within the Technical Specification limits.

The Unit 1 SSPV assemblies were replaced with new assemblies during the shutdown on March 17, 1996. The new assemblies utilize Buna-N exhaust diaphragms. From a review of industry data, the most limiting documented case of Buna-N diaphragm service life is 2.9 years (Operational Experience Report 7543). Thus, it is expected that the current SSPV configuration will provide acceptable scram time performance throughout the present cycle.

As an interim measure, monitoring equipment has been temporarily installed on twelve Unit 1 SSPVs to obtain response time data collection during weekly Reactor Protection System functional tests. This increased monitoring will allow earlier detection of diaphragm degradation.

A sample population of the Unit 1 diaphragms will be inspected prior to the upcoming B111R1 refuel outage to determine if degradation has occurred (i.e., stiffening or cracking) and the need for exhaust diaphragm replacement.

SAFETY ASSESSMENT

The safety significance of the scram event is minimal. Following the scram the plant responded as designed and consistent with the analyses presented in the Updated Final Safety Analysis Report. In addition, the Unit 1 Residual Heat Removal, High Pressure Coolant Injection, Core Spray, and Reactor Core Isolation Cooling systems were operable at the time of the event. The manual scram was inserted prior to exceeding the limits for turbine vibration as established by plant procedure. Post scram testing and turbine data review indicate no turbine system component abnormalities resulted from the increased turbine vibration condition.

Control rods are inserted to assure thermal limits are not exceeded during design transients. Field and laboratory testing has confirmed that the slow insertion time condition is being caused by delayed operation of the SSPV. This delayed operation results in a delay in the start of control rod motion but does not affect the speed of travel once motion has begun nor result in a complete failure of the valve to operate. In addition, BNP engineering evaluation has determined that the insertion times obtained from the testing performed from January 20 through January 22, 1996, would not have challenged the core licensing basis nuclear safety criteria. Additional GE analyses determined that the observed degradation of the 5% average scram insertion time does not impact any safety analysis or threaten any safety limits.

PREVIOUS SIMILAR EVENTS

Previous similar events involving a manual reactor shutdown due to main

turbine vibration were not identified.

EIIS COMPONENT IDENTIFICATION

System/Component EIIS Code

Control Rod Drive AA

Main Turbine System TA

Hydraulic Control Unit HCU

Enclosure

List of Regulatory Commitments

The following table identifies those actions committed to by Carolina

Power & Light Company In this document, Any other actions discussed in

the submittal represent intended or planned actions by Carolina Power &

Light Company. They are described to the NRC for the NRC's information

and are not regulatory commitments. Please notify the Manager-Regulatory

Affairs at the Brunswick Nuclear Plant of any questions regarding this

document or any associated regulatory commitments.

Committed

Commitment date or outage

Actions to resolve the control rod slow scram N/A

times were previously committed in LER 2-96-01.

Recommendations for coping with increased main 8/1/96

turbine vibration will be incorporated into the

plant shutdown procedure.

ATTACHMENT 1 TO 9606200154 PAGE 2 OF 2

CP&L

Carolina Power & Light Company

P.O. Box 10429 MAY 30 1996

Southport, NC 28461-0429

SERIAL- BSEP 96-0218

10 CFR 50.73

U.S. Nuclear Regulatory Commission

ATTN: Document Control Desk

Washington, D. C. 20555

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2

DOCKET NO. 50-325 AND 50-324/LICENSE NO. DPR-71 and DPR-62

LICENSEE EVENT REPORT 1-96-002 SUPPLEMENT ONE

Gentlemen:

In accordance with the Code of Federal Regulations, Title 10, Part 50.73, Carolina Power & Light Company submits the enclosed Licensee Event Report supplement.

Please refer any questions regarding this submittal to Mr. Mark Turkal at (910) 457-3066.

Sincerely,

W. Levis, Director - Site Operations

Brunswick Nuclear Plant

SFT/sft

Enclosures

1. Licensee Event Report

2. Summary of Commitments

cc: Mr. S. D. Ebneter, Regional Administrator, Region ii

Mr. D. C. Trimble, NRR Project Manager - Brunswick Units 1 and 2

Mr. C. A. Patterson, Brunswick NRC Senior Resident Inspector

The Honorable H. Wells, Chairman - North Carolina Utilities

Commission

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